BMNR - 3441
1454

CONTROL EFFECTS OF INTRODUCED AND NATIVE PREDATORS ON THE BALSAM WOOLLY APHID

By

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(A paper for presentation at the 44th annual meeting of the Entomological Society of America, Pacific Branch. Spokane, Washington, June 28-30, 1960)

Since 1957, the Pacific Northwest Forest and Range Experiment Station of the U. S. Forest Service has been investigating biological control of an introduced forest pest, the balsam woolly aphid (Chermes piceae Ratz.). The investigations have been concerned with two things: Introduction of foreign insect predators and study of native arthropods that feed on the aphid. Objectives of our paper are to describe the aphid problem, what we are doing in the way of biological control, and results to date.

The Problem

The balsam woolly aphid is a homopteron of the family Chermidae that damages forest trees in many parts of the world. It was introduced about 1900 to eastern Canada and the northeastern United States where it is highly destructive to balsam fir. By 1930, the insect was found on the Pacific Coast attacking ornamental and other true firs (Abies sp.), mainly outside important forested areas. In 1954, however, it was discovered causing widespread tree killing in high-value forests in western Washington and Oregon. The infestation expanded rapidly and by 1957 covered more than 600 thousand acres in the two states. The infested area has declined somewhat in size since 1957, but several billion board feet of commercial timber has been killed, and trees on important watershed and recreation areas have been damaged extensively.

A balsam woolly aphid attack usually takes one of two forms - it may occur in the crown of a tree, or it may occur on the main stem. Crown attacks kill or inhibit the buds and cause a condition called "gouting"; trees so-attacked die slowly. Attacks on the main stem are usually more serious. Here the insect indirectly affects the tracheids and quickly reduces the moisture exchange between the roots and the crown. Such infestations may kill a tree in one or two years. The two types of attack are important considerations in the biological control program.

Introduction of Foreign Predators

In its European environment, the balsam woolly aphid has numerous natural enemies, mainly predaceous flies and beetles. As usually occurs, these were not introduced with the pest. For several years, the Division of Forest Biology of the Canadian Department of Agriculture has imported balsam woolly aphid predators, with some degree of success. After review of Canadian experiences, the decision was made to proceed with a predator introduction program in the Pacific Northwest. A cooperative arrangement was made between the U. S. Forest Service and the Canadian Department of Agriculture whereby we would receive shipments of predators being collected in Europe by the Canadian-financed Commonwealth Institute of Biological Control and, the U. S. Forest Service would explore collecting possibilities in Japan. Beginning this year, we also are receiving shipments from Pakistan and India that are financed by U. S. Public Law 480 funds.

Since 1957, a total of 55,620 predators, representing 15 species, have been liberated in Oregon and Washington. Species representing the following orders and families have been introduced:

Diptera

Chamaemyiidae	-	3 species
Itonididae	-	1 species

Coleoptera

Coccinellidae	-	10 species
Derodontidae	-	1 species

Predators have been received from Australia, Czechoslovakia, Germany, India, Japan and Pakistan. An additional species, of European origin, has been received from Maine where it became established following colonization in nearby New Brunswick.

Liberations have been made on Pacific silver fir, subalpine fir, and grand fir at widespread points in Oregon and Washington. When the size of shipments permits, we release in colonies of approximately 1000 specimens each. The beetle predators have predominantly been released "free" (i.e., merely turning them loose at the bases of trees with heavy bole infestations), whereas the flies are usually liberated in cages.

Success of Establishment

So far, at least 5 species of predators have produced progeny in the field. They are the flies Aphidoletes thompsoni Mohn, Cremifania nigrocellulata Cz. and Leucopis obscura (Hal.); and the beetles Laricobius erichsonii Rosenh. and Aphidecta obliterata L.

Overwintered progeny have been recovered from all these species except Aphidecta. Eight of the fourteen species released to date were colonized for the first time in 1959; accordingly, it is too early to evaluate their success.

At present, Aphidoletes thompsoni and Laricobius erichsonii appear to be the best established and most effective. Both species have sharply reduced the host population on trees near release points, and both show indication of rather rapid dispersal. Aphidoletes may prove to be the best of the two because it produces several generations annually; Laricobius has only 1 generation per year but preys in both the larval and adult stages. Because our quantitative studies of predator effectiveness are just beginning, it is yet unknown whether either Laricobius or Aphidoletes can reduce the host population below tree-killing intensity, and whether they will survive under conditions of low host population density.

Study of Native Predators

The study of native predators feeding on Chermes in the Pacific Northwest was made from 1957 to 1959 in cooperation with Oregon State College. Objectives of the study were to catalog the predators and to determine their effectiveness.

The study revealed 14 insects and two mites as being definitely predaceous on the balsam woolly aphid. Ten of the insects were in the Order Diptera, three in Neuroptera, and one in Coleoptera. The most abundant predators were four syrphids:

1. Cnemodon rita
2. Syrphus vitripennis
3. Syrphus opinator
4. Metasyrphus lapponicus

One hemerobiid, Hemerobius neadelphus, was also moderately abundant. In addition to the known predators, nine other species of arthropods were collected in association with the balsam woolly aphid. All have a reputation for preying on insects, but none were actually observed feeding.

In two areas, intensive studies were made on the effectiveness of native predators in reducing chermes populations on Pacific silver fir and subalpine fir. The conclusions of this study were that native predators do not effect significant control of balsam woolly aphid, except occasionally in small, isolated areas. The ineffectiveness of the predators is attributed to four factors:

1. An insufficient number of predators.
2. Erratic occurrence of the predators from area to area, and between trees in the same area.
3. Poor syncronization of the predators' life cycle with that of the aphid.
4. Inability of the predators to sustain themselves on low host populations.

Conclusion

From observations to date, there are no indications that we will obtain spectacular control benefits from either introduced or native predators. However, it is much too early to assess effectiveness, particularly of the foreign predators.

It is well to point out that control of many forest pests need not be as absolute as that of pests attacking agricultural crops. There are good possibilities that we can integrate control through forest management procedures with that of biotic agents such as insect predators. In our biological control program, using predators, our optimistic hope is that we can accomplish the following three objectives:

1. Find predators which can seek out scattered areas of infestation, reduce heavy stem attacks below the tree-killing level, and then maintain the aphid population at acceptably low density.
2. Find predators that will search out and control the light twig infestations which cause the slow but steady decline of trees.
3. Find a predator complex which will attack at different times throughout the season, which will survive in a variety of different environments, and which will operate at low as well as high prey densities.

The likelihood of accomplishing any or all of these objectives is a decided gamble. However, in view of the values at stake, the investment we are making in this program seems justified.